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UNITED STATES BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

ACCIDENT-COST DATA ON MOST OF THE BITUMINOUS COAL MINED EAST OF THE MISSISSIPPI RIVER FROM APRIL 1, 1934, TO JANUARY 31, 1935

BY

J. J. FORBES AND C. W. OWINGS

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ACCIDENT-COST DATA ON MOST OF THE BITUMINOUS COAL MINED EAST OF THE MISSISSIPPI RIVER FROM APRIL 1, 1934, TO JANUARY 31, 1935[1]

By J. J. Forbes[2] and C. W. Owings[3]

The economic necessity of eliminating unnecessary costs incident to fatalities and injuries is frequently overlooked by mine managers and mine workers. Accident rates in the coal-mining industry are higher than those in nearly all other industries of the United States. In such a highly competitive industry as coal mining the cost per ton of coal, which is directly and indirectly affected by the death and injury rates, in many cases determines whether a coal mine can be operated profitably.

The object of this circular is to direct attention to the economic losses that are sustained and to the profits that might be made were an effective safety policy to be adopted, which would prove beneficial to employer and employee alike in coal mining.

RELATION OF COMPENSATION INSURANCE TO PROFIT AND LOSS

Surprising comparisons can be made between the cost of accidents and the margin between receipts and the cost of producing and selling coal by means of figures recently issued by the Division of Research and Planning of the National Recovery Administration[4] on costs of producing coal and bituminous compensation insurance in 12 States east of the Mississippi River. Compensation-insurance costs include compensation, hospitalization, medical care, and similar items of expense, usually designated the direct cost of accidents as distinct from the numerous less-evident but frequently much more expensive indirect costs that almost invariably accompany accidents.

Some of these direct-cost figures are given in table 1. The data are arranged according to coal fields and not according to States. Although figures are given for only part of the mines in each district, they may be considered representative as they constitute 79-1/2 percent of the commercial production in Pennsylvania, Ohio, Maryland, Michigan, Kentucky (except western Kentucky), West Virginia, and Virginia for a 10-month period ended January 31, 1935; about 85 percent of commercial production in Illinois and Indiana during the same period; and approximately 93 percent of commercial production in Alabama, Tennessee, and Georgia during the 9-month period ended December 31, 1934. Parentheses indicate loss. In the eastern subdivision of Division I, the average loss per ton was 5.79 cents compared with a compensation-insurance or direct cost per ton of 5.38 cents. In other words, if accidents had been eliminated, the loss per ton would have averaged 0.41 cent. In western Pennsylvania the average loss per ton was 3.23 cents, whereas the cost of compensation insurance or direct accidents was 6.47 cents per ton; if the compensation cost had been 50 percent less, the coal companies in this district could have "broken even." In the Ohio subdivision, coal was mined at a profit in spite of relatively high compensation-insurance cost; with effective measures taken to prevent accidents, this profit very probably could have been doubled. In Michigan, the cost of compensation insurance was nearly twice as great as the loss per ton of coal sold. In the Panhandle district of West Virginia, coal was sold at an average profit of 2.70 cents per ton, but if half of the compensation cost had been eliminated a profit of nearly 5 cents per ton would have been realized. In other parts of West Virginia a similar condition exists. In Indiana and Illinois (Division II) coal was sold at a profit that could have been increased materially by reducing compensation-insurance costs. The mines in Division III operated at an average loss of 4.44 cents per ton, including a compensation-insurance cost of 3.12 cents per ton.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6896".

[2] Supervising engineer, Safety Division, U.S. Bureau of Mines, Pittsburgh, Pa.

[3] Associate mining engineer, Safety Division, U.S. Bureau of Mines, Pittsburgh, Pa.

[4] Henderson, Leon, Berquist, F. E., and Gordon, E. B., Bituminous Coal Statistics for the Period of April 1934 through January 1935: Division of Research and Planning, National Recovery Administration.

Table 1 indicates the difference in profit and loss in the various districts and the variation in direct cost of accidents as reflected by compensation-insurance costs. In many districts a reduction of less than 1 cent a ton in direct or compensation-accident costs would have allowed the mines to operate at a profit. The figures in table 1 are important because they compare costs in different small districts; however, a comparison of profits and losses with direct compensation insurance costs by States provides a broader means of comparison.

Table 2 shows that only 4 of 12 States east of the Mississippi River had an average profit from the operation of bituminous-coal mines in the period under discussion. Illinois, Indiana, Ohio, and West Virginia had average profit ranging from 5.53 cents per ton in Ohio to 8.65 cents per ton in Illinois, or an average profit of 6.85 cents per ton. Compensation insurance or direct cost ranged from 3.88 cents per ton in West Virginia to 8.64 cents per ton in Ohio, or an average direct cost of 4.59 cents per ton for accidents. If this expense had been reduced to 1 cent per ton, the average profit would have been 10.44 cents per ton, giving a total profit for the 547 mines in these four States of over $12,000,000 instead of $7,622,413.09.

TABLE 1. - Some bituminous coal-mine costs, by divisions, April 1934 to January 1935, compiled by NRA, Division of Research and Planning

	Number of mines	Total net tons	Total cost per ton	Total income per ton	Profit or (loss)[1] per ton	Compensation	
						Total cost	Cost per ton
DIVISION I							
stern Subdivision:							
otal Eastern Subdivision	156	20,249,105	$2.1182	$2.0603	$(0.0579)	$1,089,737.00	$0.0538
Barnesboro	17	1,969,002	2.1785	1.9228	(.2557)		.0545
Blacklick	4	530,279	2.0657	1.8475	(.2182)		.0555
Broadtop	6	487,726	2.6049	2.3071	(.2978)		.0442
Clearfield	17	1,138,366	2.0696	2.0368	(.0328)		.0763
Nanty-Glo	7	2,350,359	2.1030	2.1263	.0233		.0641
Reynoldsville ..	24	5,046,497	1.9200	1.9167	(.0033)		.0360
South Fork	42	5,112,690	2.2086	2.2061	(.0025)		.0599
Southern Somerset	18	2,291,495	2.2791	2.0831	(.1960)		.0629
Total Eastern Pennsylvania..	135	18,926,414	2.1218	2.0570	(.0648)	1,027,583.69	.0543
Maryland	12	720,125	2.1107	2.0970	(.0137)	37,828.26	.0525
Upper Potomac (W. Va.)	9	602,566	2.0151	2.1204	.1053	24,325.05	.0403
Total Maryland & Upper Potomac.	21	1,322,691	2.0672	2.1076	.0404	62,153.31	.0470
stern Pennsylvania							
Total Western Pennsylvania.	148	26,454,244	1.9408	1.9085	(.0323)	1,710,943.82	.0647
Thick Vein (including "head coal")	37	9,073,994	1.8966	1.9394	.0428		.0567
Thin Vein -							
Avella District	4	448,127	1.8479	1.6538	(.1941)		.0814
Panhandle ...	27	6,547,018	1.9856	1.9245	(.0611)		.0772
Youghiogheny District ...	4	1,333,132	2.0952	2.0149	(.0803)		.0767
Connellsville-Point Marion:							
Pittsburgh Bed	5	286,458	1.7392	1.6214	(.1178)		.0721
Sewickley and Hunkers	5	362,193	1.6607	1.5392	(.1215)		.0719
Coking	15	2,512,997	1.9281	1.8454	(.0827)		.0530
Upper Freeport, Conemaugh....	16	830,335	2.0390	1.9257	(.1133)		.0804
Thick Freeport	10	3,086,697	1.8553	1.8928	.0375		.0568
Butler, Mercer	10	391,664	1.9705	2.0163	.0458		.0927
Greensburg....	6	1,118,393	2.2103	1.8937	(.3166)		.0526
Latrobe	5	252,884	1.9979	1.8368	(.1611)		.0834
Ligonier	4	210,352	1.8927	1.8601	(.0326)		.0668

Parentheses () indicate a loss or deficit.

TABLE 1. - Some bituminous coal-mine costs, by divisions, April 1934 to January 1935, compiled by NRA, Division of Research and Planning (continued)

	Number of mines	Total net tons	Total cost per ton	Total income per ton	Profit or(loss)1/ per ton	Compensation	
						Total cost	Cost per ton
DIVISION I (Cont'd) Ohio Subdivision:							
Total Ohio Subdivision	57	9,694,871	$1.8031	$1.8584	$ 0.0553	837,515.66	$0.0864
Crooksville, Shawnee, Hocking, Pomeroy, and Jackson ..	21	2,736,609	2.0062	1.9256	(.0806)		.1085
Massillon and Leetonia	7	618,089	1.9737	1.9863	.0126		.0905
Cambridge, No. 8, and Amsterdam-Bergholz	29	6,340,173	1.6988	1.8169	.1181		.0764
Michigan Subdivision	5	347,185	3.1848	3.1625	(.0223)	14,781.60	.0426
Panhandle of West Virginia	5	1,965,478	1.7272	1.7542	.0270	82,422.61	.0420
Northern West Virginia:							
Total Northern West Virginia .. Subdivision	58	10,468,115	1.6671	1.6214	(.0457)	372,772.25	.0356
Pittsburgh, Redstone	39	8,354,070	1.6281	1.6057	(.0224)		.0334
Sewickley, Freeport & Kittanning	7	1,127,880	1.6283	1.4890	(.1393)		.0389
All Preston County	6	260,290	1.8486	1.7815	(.0671)		.0330
Sewell	6	725,875	2.1107	1.9499	(.1608)		.0566
Southern No.1, Smokeless:							
Total Southern No.1 Subdivision	156	32,294,256	1.9473	2.0369	.0938	1,368,092.45	.0424
Pocahontas	68	17,151,302	1.8955	1.9861	.0984		.0422
Greenbrier	9	1,240,308	1.8784	1.9529	.0745		.0385
Winding Gulf ...	41	7,519,891	1.9884	2.1244	.1360		.0406
New River	38	6,382,755	2.0513	2.0864	.0351		.0457

1/ See footnote page 3.

TABLE 1. - Some bituminous coal-mine costs, by divisions, April 1934 to January 1935, compiled by NRA, Division of Research and Planning (continued)

	Number of mines	Total net tons	Total cost per ton	Total income per ton	Profit or(loss)1/ per ton	Compensation	
						Total cost	Cost per ton
VISION I(Cont'd.)							
uthern No. 2:							
otal Southern No. 2 Subdivision ..	208	36,835,665	$1.8199	$1.8447	0.0248	$1,408,735.06	$0.0383
Big Sandy, Elkhorn	24	6,251,524	1.9260	1.9106	(.0154)		.0323
Harlan	8	1,850,910	1.9550	1.9578	.0028		.0561
Hazard	26	2,379,677	1.9256	1.8888	(.0368)		.0537
Kanawha	47	10,113,616	1.8078	1.8766	.0688		.0332
Logan	36	7,583,386	1.5721	1.7103	.1382		.0322
Southern Appalachian	14	1,460,494	2.0472	1.9164	(.1308)		.0658
Virginia	23	3,754,482	1.9636	1.8813	(.0823)		.0385
Williamson	30	3,441,576	1.8103	1.7653	(.0450)		.0448
DIVISION II							
ndiana:							
otal Indiana ...	46	8,892,423	$1.5203	$1.5985	.0782	$ 426,471.13	.0479
Brazil-Clinton .	14	2,291,764	1.7206	1.7082	(.0124)		.0644
Linton-Sullivan.	24	3,905,547	1.5323	1.6376	.1052		.0494
Princeton-Ayrshire	8	2,695,112	1.3326	1.4486	.1160		.0319
linois							
otal Illinois ..	103	26,262,250	1.5531	1.6396	.0865	1,267,455.95	.0483
Northern	7	1,565,804	1.7249	2.0545	.3296		.0348
Central-Peoria..	13	2,477,160	1.5887	1.6702	.0815		.0348
Central-all others	24	7,175,350	1.5134	1.6349	.1215		.0515
Total Central.	37	9,652,510	1.5327	1.6439	.1112		.0472
Belleville	33	5,425,842	1.3735	1.4082	.0347		.0361
Southern	26	9,618,094	1.6468	1.6981	.0513		.0584

/ See footnote page 3.

TABLE 1. - Some bituminous coal-mine costs, by divisions, April 1934 to January 1935, compiled by NRA, Division of Research and Planning (continued)

	Number of mines	Total net tons	Total cost per ton	Total income per ton	Profit or (loss)[1] per ton	Compensation Total cost	Compensation Cost per ton
DIVISION III[2]							
Alabama, Southern Tennessee, and Georgia:							
Total Subdivision	50	4,279,457	$2.2983	$2.2539	($0.0444)	$ 133,734.00	$0.0312
Alabama, Dist. 1	7	612,904	2.7350	2.8160	.0810		.0282
Alabama, Dist. 2	20	2,035,645	2.0721	1.9996	(.0725)		.0266
Alabama, Dist. 3	11	792,959	2.3885	2.4004	.0119		.0338
Alabama, Dist. 4	4	274,638	3.0357	2.9055	(.1302)		.0591
Total Alabama	42	3,716,146	2.3202	2.2867	(.0335)	114,486.00	.0308
Southern Tenn. and Ga., Dist. 1	4	411,728	2.1279	2.0548	(.0731)	14,265.00	.0347
Southern Tenn. and Ga., Dist. 2	4	151,583	2.2267	1.9906	(.2361)	4,983.00	.0329
Total Southern Tenn. and Ga.	8	563,311	2.1545	2.0376	(.1169)	19,248.00	.0342

1/ See footnote page 3.

2/ Summary for 9 months, April to December, 1934; January 1935 not available.

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TABLE 2. - Comparison of realization and accident cost of bituminous coal in central and eastern United States, April 1, 1934, to January 31, 1935, from figures compiled by NRA, Division of Research and Planning

	Number of mines	Production, tons	Total cost[1] per ton	Total income[2] per ton	Margin		Compensation insurance	
					Total	Per ton	Total	Per ton
Alabama[3]	42	3,716,146	$2.3202	$2.2867	$(124,309.00)[4]	$(0.0335)	$ 114,486.00	$0.0308
Illinois	103	26,262,250	1.5531	1.6396	2,271,337.35	.0865	1,267,455.95	.0483
Indiana	46	8,892,423	1.5203	1.5985	695,172.61	.0782	426,471.13	.0479
Kentucky[5]	58	10,482,111	1.9310	1.9140	(178,285.96)	(.0170)	433,672.22	.0414
Maryland	12	720,125	2.1107	2.0970	(9,913.35)	(.0137)	37,828.26	.0525
Michigan	5	347,185	3.1848	3.1625	(7,769.39)	(.0223)	14,781.60	.0426
Ohio	57	9,694,871	1.8013	1.8584	535,771.63	.0553	837,515.66	.0864
Pennsylvania	283	45,380,658	2.0163	1.9705	(2,079,322.76)	(.0458)	2,738,527.51	.0603
Tennessee and Georgia[3]	22	2,023,805	2.0770	1.9501	(256,920.47)	(.1269)	115,391.76	.0570
Virginia[6]	23	3,754,482	1.9636	1.8813	(308,573.65)	(.0823)	144,709.84	.0385
West Virginia[7]	341	66,468,993	1.8261	1.8881	4,120,131.50	.0620	2,581,821.60	.0388
Total	992	177,743,049			$4,657,318.51	$ 0.0262	$8,712,661.53	$0.0490

[1] Capital charges and cost not directly related to coal-mine operations are not included. Taxes on non-operating reserves excluded.

[2] Income from sales of coal.

[3] For 9 months only; figures for January 1935 not included.

[4] Parentheses () indicate credit or operating deficit.

[5] Part of Pike County included in West Virignia; does not include western Kentucky.

[6] Part of Tazewell County included in West Virginia.

[7] Includes part of Pike County, Ky., and Tazewell County, Va.

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The eight States in which coal was produced at a loss (Alabama, Kentucky, Maryland, Michigan, Pennsylvania bituminous, Tennessee, Georgia, and Virginia) had losses ranging from 1.37 cents per ton in Maryland to 12.69 cents per ton in Tennessee and Georgia, an average loss of 4.46 cents per ton and a total deficit of $2,965,094.58 for the mines in this group. The compensation insurance ranged from 3.08 cents per ton in Alabama to 6.03 cents per ton in Pennsylvania. The average direct cost for this group of mines was 5.42 cents per ton, and from this a total loss of $3,599,397.19 was experienced. If the compensation cost in this group had been reduced to 1 cent per ton, the deficit would have been about $29,000; if this figure had obtained in Kentucky, Maryland, and Michigan, the coal mines in these States would have been operated at a profit of 1.03 to 2.88 cents per ton, and Pennsylvania bituminous mines would have had an average profit of about half a cent a ton.

The profit for the 992 mines included in the study was $4,657,318.51, comprising a profit of $7,622,413.09 (an average of 6.85 cents per ton) in Illinois, Indiana, Ohio, and West Virginia and a loss of $2,965,094.58 (4.46 cents per ton) in the other eight States. The compensation insurance paid by these 992 mines was $8,712,661.53 or over a million dollars more than the profit in the 4 States and nearly twice as much as the profit for the 12 States. In Pennsylvania, $2,738,527.51 was paid for compensation insurance, or nearly three fourths of a million dollars more than the deficit. On the other hand, the 341 mines in West Virginia had a profit of $4,120,131.50 for the 10 months, with a direct-accident cost of $2,581,821.60, or about five eighths as much as the profit.

The cost of compensation insurance in those States in which a loss was sustained is nearly 1 cent higher than the compensation insurance in those States in which the mines operated at a profit. In other words, if the mines in the States in which the coal, on an average, was sold at a loss could have operated at the same compensation-insurance rates as in the States in which coal was sold at a profit, more than $650,000 would have been saved.

DIRECT COST

Compensation insurance represents only part of the costs of accidents. Costs of industrial accidents to the employer have been shown by H. W. Heinrich, of the Travelers' Insurance Co., to consist of 20 percent direct costs and 80 percent indirect costs. It is doubtful whether the same ratio applies to mine accidents. The following table was compiled from data in Accident Facts, 1935 edition, issued by the National Safety Council:

TABLE 3. - Comparison of days lost per 1,000 man-hours in certain industries, 1934.

	Total	Fatalities and permanent total disabilities	Permanent partial disabilities	Temporary disabilities
All industries	1.70	1.02	0.39	0.29
Cement	3.89	3.01	.74	.14
Construction	4.32	3.41	.35	.56
Lumbering	4.80	2.12	1.05	1.63
Mining	10.19	7.40	1.30	1.49

On this basis, the severity of mining injuries is six times as great as that of "all industries" and more than twice as great as that of lumbering which ranks second in severity of injuries.

Mining has a fatality and permanent total-disability severity rate 7-1/4 times greater than that of "all industries" and more than twice the rate for the construction industry. Permanent partial disabilities in mining are 3-1/3 times as much as the average for all industries, and temporary disabilities are more than 5 times the average. Consequently, the direct cost of accidents in mines is higher than in all industries, although the cost per accident will not be 6 times as high as for all industries. For instance, in West Virginia in 1933-34 the cost of noncoal industrial injuries averaged $145 per injury compared with an average of $215 per injury in coal mines, a ratio of more than 1 to 1-1/3.

INDIRECT COST

The indirect costs include lost time, lost production, broken or idle equipment, replacing injured workers, overhead, and reduced efficiency. Rush N. Hosler, of the Pennsylvania Compensation Rating Bureau, estimates that bituminous mine employees in Pennsylvania lose $3 for every dollar of compensation paid. At one mine in West Virginia the workers lost nearly $2 for each dollar paid as compensation; the average for the State is slightly higher. It is reasonable to suppose that in the bituminous mines east of the Mississippi River injured workmen lose at least twice as much as they receive in compensation.

An accident causes other employees to stop work to see what is happening and to help injured workmen; this entails a direct loss for tonnage men, and a loss to employers due to time lost by men paid on an hourly basis. When a fatality results, in most mines all employees cease work for the remainder of the shift, with a direct wage loss to employees and numerous indirect losses to the employer. The time of supervisory employees is required to investigate and make reports on the accident, this and other like demands on the time of operating employers increasing the cost of operating the mine.

The indirect loss from a fatality may be estimated. In the 992 mines considered in the study on which this paper is based, the average employment was 415 men. The average production in tons per man-day ranged from 1.56 in Georgia to 7.75 in Indiana, and the general average for the 992 mines was 4.44 tons per man-day. A study to determine the time of day when accidents occurred shows that about 45 percent took place before noon. The tonnage produced is in about the same proportion; consequently, if work ceases throughout the mine when a man is killed, about half of the daily tonnage for the day on which a fatality occurs is lost for each fatality, or 2.22 tons for an average of 415 men, equivalent to 921 tons, upon which an average profit of 2.62 cents per ton could have been realized, or a total profit loss of $24.13 through loss of tonnage caused by one death. His loss may be recovered later, but generally this is not done. On this basis, the loss of $24.13 per individual on the 873 deaths that occurred in these States in 1934 amounts to $21,065.49.

The loss to the tonnage man ranges from $0.52 to $2.15, with a mean of $1.34 per man. The day man loses from $0.66 to $1.30, or an average of $0.93. Assuming that in the average mine of 415 employees 215 were tonnage men and 200 were day men, the average wage loss to the workers in connection with a fatality to a fellow worker amounts to $474.10. The loss to employees in the 873 deaths would be approximately $414,000.

The loss in nonfatal injuries is difficult to estimate. Assuming that for each permanent total and permanent partial disability it was necessary to take the injured man to the surface or the shaft bottom, the loss in tonnage probably would average 25 tons per case, based on an average loss of 1 hour for the trip. On this basis, in 1934, for the 1,859 permanent total and partial disabilities in the 12 States, 46,475 tons were lost at an average profit of 2.62 cents per ton, or $1,217.65. The loss to employees in decreased tonnage and other distractions due to the occurrence of these accidents would undoubtedly have been more than $100,000.

Accidents frequently follow other accidents, due to excitement following the original injury. For instance, after a miner was injured in a gassy coal mine, he was transported to the shaft bottom in a mine car hauled by a gathering locomotive; the brakeman neglected to close the ventilating door and, when the locomotive returned an hour later, an accumulation of methane caused by short circuiting of air due to the opened door was ignited by an arc from the trolley wheel, and two men were injured by the explosion. Another fairly typical accident occurred in a coal mine in which a miner was killed by a fall of roof; while his body was being extricated, another miner rushed in to help without testing the roof and was killed by a second fall. Such injuries increase an already large accident cost.

A large cost, not usually considered, is overhead expense that continues even when the mine is idle. The average cost of overhead at the 992 mines, as given by the figures of the Division of Research and Planning of the N. R. A., was 10.48 cents per ton; using the average employment and production figures previously assumed, the overhead cost for a fatality, due to lost production, or 921 tons, is $96.52, or a total estimated loss of $84,261.96 on the 873 deaths. The average overhead expense on lost tonnage for permanent total and partial injuries is $2.62 per disability, or $4,870.58 for 1,859 such disabilities.

Due to the higher severity rate of mine injuries compared with that in other industries, it appears that the indirect cost - estimated to be four times the direct cost for industry in general - is about three times the direct cost of coal-mine injuries. On this assumption, the indirect cost of coal-mine accidents in the 12 States considered is $0.147 per ton; if direct cost is reduced to 1 cent per ton, a direct saving of 3.90 cents per ton would accrue and a saving of 11.70 cents per ton in indirect costs would result - a total saving of 15.60 cents per ton, which would have allowed an average profitable operation in all of the 12 States.

COST OF INJURIES

Accident costs differ according to the degree of the injury and the rates allowed under the laws of the various States, as shown in Bureau of Mines publications that give costs of coal-mine accidents. The cost of temporary injuries in 10 States ranges from $33 to $97 per claim. The mean cost of temporary injuries is probably about $70. Permanent partial disabilities range from $598 to $1,177, with a mean cost of about $850. Permanent total disabilities range from an average of $6,015 to $18,750, with a mean cost of $14,000. The cost of fatalities ranges from $2,521 to $5,052; the mean cost of fatalities is about $4,000. The cost per claim, including all types of compensable injuries, ranges from $134 to $396, or an average of $277. The actual cost of the injuries may be much greater than the average cost. The average cost of fatal and nonfatal injuries is generally used in estimating the accident cost of injuries by individual mining companies, and the maximum cost possible to be charged to the operating company frequently is overlooked. The maximum charges for the State in which a mine is situated should be determined and the cost considered in estimating cost of injuries.

In the calendar year 1933, the latest year for which data are available, for every 53 nonfatal compensable accidents in the bituminous mines of the United States there was one fatality. A permanent total disability was sustained for every 1,292 nonfatal injuries and a permanent partial disability for every 37 nonfatal disabilities. Similar data are given in table 4 for the bituminous mines in the 12 States considered. The ratio of number killed to the number nonfatally injured is between 1 to 25 and 1 to 148; the average ratio is 1 to 49. For every 15.6 deaths, one workman is totally disabled; and for each death, 2.1 sustain permanent partial disabilities. Every mining company should have similar information for the State or the section in which its mines are operating, and an estimated cost of accidents should be prepared annually and be included in the budget. Such information should point to definite measures to reduce the accident costs. It has been shown that the average cost of accidents during the 10-month period covered by the N. R. A. figures was 4.90 cents per ton of coal. This cost should not exceed 1 cent a ton, and even lower figures have been obtained by companies that have put forth an earnest effort to reduce accidents.

REDUCTION IN ACCIDENT COSTS

Accident data and costs for three mines, as given in table 5, show that safety can be achieved and accident costs greatly reduced by taking proper steps. In mine A the number of noncompensable accidents was reduced by more than three fourths, in 4 years, compensable accidents by three fifths, and fatalities by one half, while a reduction of two thirds was obtained in all classes of accidents. During the same period the accident cost per ton was reduced 62 percent; although the administrative expense of the safety department increased 42 percent, the total cost of accidents was reduced 3 cents per ton.

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TABLE 4. - Fatal and nonfatal accidents, 1934

State	Killed	Permanent total disabilities	Permanent partial disabilities	Temporary disabilities	Total nonfatal disabilities	Ratio, number killed to number non-fatally injured
Alabama	35	1	59	1,336	1,396	1 : 40
Illinois	90	3	236	7,660*	7,899*	1 : 88
Indiana	21	1*	26*	1,890*	1,917*	1 : 91
Kentucky	118	8	216	3,844	4,068	1 : 34
Maryland	10	1	6	338	345	1 : 35
Michigan	2	-	1	294	295	1 :148
Ohio	90	2	73	2,936	3,011	1 : 33
Pennsylvania (bitum)....	164	17*	165*	12,390*	12,572*	1 : 77
Tennessee and Georgia ..	19	2	2	468	472	1 : 25
Virginia	46	13	78	1,074	1,165	1 : 25
West Virginia	278	8	941*	9,000*	9,949*	1 : 35
Total	873	56*	1,803*	41,230*	43,089*	1 : 49

* Estimated; subject to revision.

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TABLE 5. - Accident reduction through organized safety

	Number of accidents					Cost of accidents			
	No lost time	Non-compensable	Compensable	Fatalities	Total lost-time accidents	Accidents, per ton	Administration, safety dept., per ton	Total cost	
								Per ton	Per $100 payroll
Mine A:									
1930		190[1]	240	6	436	$0.049	$0.0019	$0.052	$5.33
1931		95[1]	100	3	198	0.044	0.0043	0.048	5.45
1932		64[1]	71	2	137	0.037	0.0039	0.041	5.92
1933		44[1]	96	3	143	0.019	0.0027	0.022	3.36
Summary, 4 years		393[1]	507	14	914	0.038	0.0031	0.041	5.02
Percent reduction, 1933 and 1930		77	60	50	67	62	142[2]	58	37
Mine B:									
1930	293	161	131	6	298	$0.031	$0.0036	$0.034	$2.81
1931	243	54	90	1	145	0.019	0.0031	0.022	1.99
1932	143	36	53	3	92	0.025	0.0035	0.028	3.09
1933	151	75	67	0	142	0.011	0.0036	0.014	1.73
Summary, 4 years	830	326	341	10	677	0.022	0.0034	0.025	2.44
Percent reduction, 1933 and 1930	49	53	49	100	52	65	0	59	38
Mine C:									
1930	45	120	114	3	237			$0.08	
1931	47	25	37	0	62			0.016	
1932	57	11	11	1	23			0.019	
1933	43	4	13	0	17			0.007	
1934 (to Dec. 1)	22	6	18	0	24			0.007	
Total	214	166	193	4	363				
Percent reduction, 1934 and 1930	51	95	84	100	90			91	

[1] Medical cases only.
[2] Increase.

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Somewhat similar results were obtained in mine B, in which there was no increase in the administrative expense of the safety department and the cost of accidents was reduced 65 percent - from 3.1 to 1.1 cents per ton - a reduction of 2 cents per ton for cost of accidents and 59 percent in total cost. At the same time the cost per $110 payroll was decreased 38 percent, or more than $1 per $100 payroll.

In mine C, from 1930 to December 1, 1934 (virtually a 5-year period) no-lost-time accidents declined 51 percent, noncompensable accidents 95 percent, compensable accidents 84 percent, and fatalities 100 percent; the total reduction in lost-time accidents was 90 percent. In accomplishing this feat the cost of accidents was decreased from 8 cents to 7 mills per ton, a saving of 7.3 cents per ton of coal produced, a reduction of 91 percent.

The reduction of coal-mine accidents is not difficult; it is primarily a question of organization, education, and supervision - education to make known to all employees the causes of accidents and how they may be prevented, and supervision to see that safety rules and regulations are formulated carefully and then obeyed and that the few men who are not willing to cooperate in accident reduction are disciplined.

SAFETY ORGANIZATION

Safety can be attained only through organizing to reduce accidents. It has been aptly said that safety virtually never originates at the bottom and works up, but that the safety idea must be thoroughly sold to the men at the head of the organization and their sincere and enthusiastic safety spirit transmitted to all employees. Responsibility for safety should rest on one person - an executive of the company in small organizations; a safety engineer in larger organizations. Everything pertaining to safety should be under his control or receive his approval. To make safety activities effective, any organization should provide for regular monthly meetings of all employees to discuss safety topics and explain rules and regulations. The Bureau of Mines sponsors the Holmes Safety Association, a national organization that provides opportunity for chapter membership in all mines; this association has been successful in aiding to reduce mine accidents.

Results obtained through numerous Holmes chapters, which provide for meetings of all employees, show what can be expected wherever these chapters are organized and given enough support to keep them active at all times. In the bituminous mines of Pennsylvania, where a large number of Holmes chapters have been organized and there is complete cooperation between the Pennsylvania Department of Mines and the Holmes Safety Association, the number of accidents has been reduced greatly. In 1930, before this work was emphasized in Pennsylvania, the death rate was 1.457 per million man-hours operated. In 1934 it is estimated that the rate was 0.944 death per million man-hours of exposure. In West Virginia, where few Holmes chapters were organized or operating in 1931, the fatality rate was 2.528 deaths per million man-hours of exposure; in 1934, the first year in which the Holmes chapters were largely attended, due to the interest of the mining people and the sponsorship of the State Department of Mines the fatality rate had decreased to 1.840 deaths per million man-hours.

It is realized that the Holmes Safety Association, or other similar organizations, cannot accomplish such results without the full cooperation of the State inspection department, miners, and operators; on the other hand, it is often difficult to accomplish comparable results in accident prevention where the Holmes or a similar plan is not followed. Where attendance at safety meetings has been small, due to changing labor conditions, accidents have increased noticeably. It is believed, therefore, that this association or a similar organization offers a definite means of educating miners in safety, thus helping to reduce the number of accidents.

SAFETY BENEFITS

The cost of conducting a safety organization is not great, ranging from 1/2 to 1-1/2 cents per ton, and in no case should it exceed 1 cent per ton. This cost is relatively small when it is considered that 2 to 3 cents per ton may be saved on accident costs.

The success of any safety undertaking depends largely upon complete cooperation between officials and employees. In one large mining company a change was made in superintendents; the new superintendent was sincere in his safety efforts, took the men into his confidence, and, through this close cooperation, was able to reduce accident costs from $3.10 per $100 of payroll to $0.31 per $100 of payroll, the saving of $2.79 being the direct result of sincerity and cooperation. This is an instance in which common sense was the means of saving an appreciable amount in dollars and cents.

CONCLUSIONS

1. Calculations based on cost data collected by the N. R. A. at most of the commercial mines in 12 States east of the Mississippi River show that the average profit realized on bituminous coal was 2.62 cents per ton.

2. The average cost of compensation insurance was 4.90 cents per ton, or 2.28 cents per ton more than the profit.

3. Coal mines in this study in Illinois, Indiana, Ohio, and West Virginia showed an average profit of 6.85 cents per ton of coal produced compared with a compensation insurance cost of 4.59 cents per ton.

4. The loss per ton of coal in the mines studied in Alabama, Kentucky, Maryland, Michigan, Pennsylvania bituminous, Tennessee, Georgia, and Virginia averaged 4.46 cents, whereas the average compensation insurance cost was 5.42 cents per ton.

5. If the actual cost of accidents had been reduced to 1 cent a ton, coal could have been produced in all States without loss.

6. The cost of compensation insurance was nearly 1 cent a ton higher in the States where coal was produced at a loss than in the States where a profit was realized.

7. The severity of injuries in the mining industry is nearly six times as high as for industry in general.

8. Due to the higher severity rates, the ratio of direct to indirect costs is also higher in mining than in industry in general. This ratio is estimated to be about one to three in bituminous mines.

9. Because a fatality results in a loss of tonnage, loss of profit to the company is estimated to have been $24.13 per death; and the estimated average loss of wages by the average of 415 workmen in the mines in the study, because of time and tonnage losses suffered when a fellow employee is killed, is $474.52 per death.

10. Overhead expenses, that continue even when the mine is idle, average 10.48 cents per ton, as given by the N. R. A.; these expenses continue when the mine is closed because of a mine death, or work is temporarily suspended on account of accidents and injuries.

11. The indirect cost of accidents in the 992 mines covered by this study during the 10-month period ended January 31, 1935, is estimated to have been 14.7 cents per ton, and the total direct and indirect cost averaged 19.60 cents per ton.

12. A reduction of direct costs of accidents to 1 cent a ton would have resulted in a total saving of approximately 15.60 cents per ton.

13. Safety is primarily a question of organization, education, and supervision.

14. Each mine or related group of mines should have a safety organization as a definite part of the operation of the mine; it should be under the direct supervision of the operating head of the company.

15. Large mines should have a safety engineer in charge of all safety work. He should have authority to enforce his recommendations. All construction work and proposed changes in systems or methods of operation should be approved, for safety features, by him.

16. Cooperation is the keynote of safety achievement. Complete agreement should exist between men and management; fairness, frankness, and courtesy are prerequisite to successful safety organization.

17. All accidents, regardless of whether injury was involved, should be investigated thoroughly, and recommendations should be made to prevent future occurrence of similar or related accidents.

18. The causes of all accidents should be determined and responsibility therefor should be placed.

19. All employees should belong to a safety organization, and meetings of all employees should be held at least monthly. Such meetings serve as a means of educating employees as to existing hazards and means of preventing accidents. Generally, closer cooperation between employer and employees results.

20. The Holmes Safety Association plan of safety organization has functioned successfully in many districts. Reduction in number of accidents and, consequently, in accident costs has generally resulted. This plan is described in United States Bureau of Mines Information Circular 6481, Organization Plan of the Holmes Safety Association, by J. J. Forbes and M. J. Ankeny.

21. Safety organization has been the means of obtaining actual accident costs of less than 1 cent a ton in a number of bituminous-coal mines.

22. Individual mine-safety records are gratifying, but whenever a large number of mines, State mining departments, and national safety bodies cooperate for general welfare, greater good is accomplished and public welfare is benefited, hence the necessity for cooperative safety effort of all persons engaged in coal mining.

Cost of compensation insurance in bituminous mines east of the Mississippi River for 10 months in 1934 was nearly 5 cents per ton of coal produced, whereas the average profit realized from the sale of coal was less than 2-2/3 cents per ton. The cost of producing coal in 8 of 12 coal-producing States in this region was nearly 4-1/2 cents per ton more than the sales realization, and the compensation insurance cost was nearly 5-1/2 cents per ton. In other words, the accident insurance cost was about 1 cent per ton greater than the loss per ton. When mines are properly organized and operated in connection with safety, actual cost of accidents should not exceed 1 cent per ton; records submitted to the Bureau of Mines show that it is possible to reduce accident costs to less than 1 cent per ton, which clearly indicates that safety not only reduces the death rate, number and severity of injuries, and human suffering, but also reduces operating costs in most instances to such an extent that mines are taken "out of the red" and return a profit. Low accident rates not only reduce accident costs but also increase the morale of employees, and the greater efficiency and productivity resulting therefrom tend to lower the operating expense.